MEMORANDUM

Date:	November 6, 2015
To:	Rob Jammerman
	Dan Carmody, PE
From:	Beau Willert, EIT (Reviewed by Roy E. Lewis, Jr., PE)
Re:	Bridlestone Estates – Fish Passage
Triad Job No.:	13-097
Copies To:	File

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The purpose of this memorandum is to summarize the inputs and assumptions for the modeling of the fish passage in the King County Backwater Program. The calculations will be memorialized in the revised version of the Final Technical Information Report provided at the final engineering phase of the project.

- The velocity of the fish passage was determined using Q=VA, Q = 97 cfs, A = 12'x2' = 24 sf, therefore the maximum velocity for the fish passage was V = 4.0 ft/sec. This meets the maximum velocity requirement for Table 4.3.2.A of the 2009 King County Surface Water Design Manual (2009 KCSWDM).

- Using existing topography the inlet elevation was found to be 343.18-ft and the outlet elevation was found to be 342.70-ft. For a fish passage span of 46-ft the slope of the bed was equal to 1.04%. This is less than the maximum Hydraulic Drop requirement for Table 4.3.2.A of the 2009 KCSWDM of 0.8-ft.

- The Entrance Loss Coefficient $k_e = 0.5$ and was found using the WSDOT 2007 Hydraulics Manual, page 3-37. The sheet from the Hydraulics Manual is provided at the end of this memorandum. This Entrance Loss Coefficient was the same value found on page 4-42 of the 2009 KCSWDM for Square-edged on 3 edges for the Box, Reinforced Concrete section of Table 4.3.1.B.

- The constants used for Inlet Control Design (K, M, c and Y) were found using Table 4.3.1.A, page 4-40 of the 2009 KCSWDM for Rectangular Box, 0° wingwall flares. The values are as follows:
    - K = 0.061, M = 0.75, c = 0.0423, Y = 0.82

- The overflow elevation of 345.68-ft (top of the roadway) was used for the King County Backwater Analysis.

The King County Backwater Analysis results are provided at the end of this memorandum for reference. Also provided at the end of this memorandum is a Surface Water Design Standards Adjustment Request. The 2009 KCSWDM, Table 4.3.2.A Fish Passage Design Criteria, states that the minimum flow depth (ft) of 0.8-ft. We request an adjustment to this minimum depth of flow. The fish passage culvert provides a maximum depth of 2-ft. Based on the results of the King County Backwater Analysis that was performed

for the fish passage box culvert the flow that provides a flow depth of 0.8-ft is 42 cubic feet per second through the culvert.

Per your request (Development Engineering) along with the King County Backwater Analysis a profile showing the hydraulic grade line and how it changes versus the water surface elevation in the channel has been provided at the end of this memorandum.

BACKWATER PROGRAM FOR BOX CULVERTS
          Tailwater Elevation:342.7 feet
              Discharge Range:2. to 97. Step of 2. [cfs]
          Overflow Elevation:345.68 feet
                          Weir:NONE
            Upstream Velocity:4. feet/sec

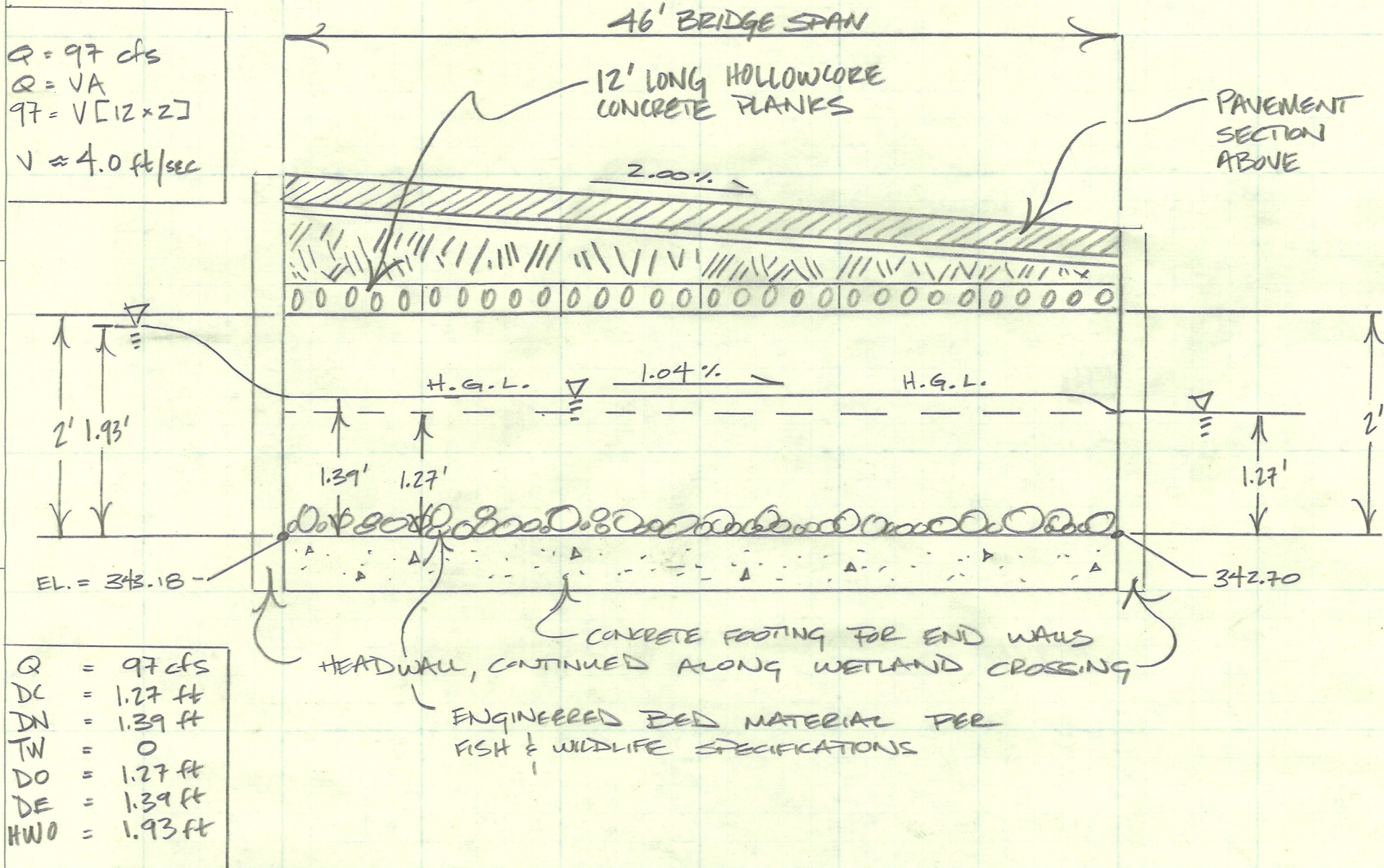PIPE NO. 1: 46 LF-144"X24" BOX @ 1.04% OUTLET: 342.70 INLET: 343.18
INTYP:10

 Q(CFS)   HW(FT)   HW ELEV. * N-FAC   DC   DN   TW   DO   DE   HWO
HWI
****
******
   2.00   0.13   343.31 * 0.028 0.10 0.13 0.00 0.10 0.13 -0.08
-0.10
   4.00   0.19   343.37 * 0.028 0.16 0.19 0.00 0.16 0.19   0.01
-0.01
   6.00   0.25   343.43 * 0.028 0.20 0.25 0.00 0.20 0.25   0.09
0.07
   8.00   0.29   343.47 * 0.028 0.24 0.29 0.00 0.24 0.29   0.16
0.14
  10.00   0.34   343.52 * 0.028 0.28 0.34 0.00 0.28 0.34   0.23
0.21
  12.00   0.38   343.56 * 0.028 0.32 0.38 0.00 0.32 0.38   0.29
0.27
  14.00   0.41   343.59 * 0.028 0.35 0.41 0.00 0.35 0.41   0.35
0.33
  16.00   0.45   343.63 * 0.028 0.39 0.45 0.00 0.39 0.45   0.41
0.38
  18.00   0.48   343.66 * 0.028 0.42 0.48 0.00 0.42 0.48   0.46
0.43
  20.00   0.51   343.69 * 0.028 0.45 0.51 0.00 0.45 0.51   0.51
0.49
  22.00   0.56   343.74 * 0.028 0.48 0.55 0.00 0.48 0.55   0.56
0.54
  24.00   0.61   343.79 * 0.028 0.50 0.58 0.00 0.50 0.58   0.61
0.58
  26.00   0.66   343.84 * 0.028 0.53 0.60 0.00 0.53 0.60   0.66
0.63
  28.00   0.70   343.88 * 0.028 0.56 0.63 0.00 0.56 0.63   0.70
0.68
  30.00   0.75   343.93 * 0.028 0.58 0.66 0.00 0.58 0.66   0.75
0.72
  32.00   0.79   343.97 * 0.028 0.61 0.69 0.00 0.61 0.69   0.79
0.76
  34.00   0.83   344.01 * 0.028 0.63 0.71 0.00 0.63 0.71   0.83
0.81
  36.00   0.87   344.05 * 0.028 0.66 0.74 0.00 0.66 0.74   0.87
0.85
  38.00   0.92   344.10 * 0.028 0.68 0.76 0.00 0.68 0.76   0.92
0.89

40.00	0.96	344.14	*	0.028	0.71	0.79	0.00	0.71	0.79	0.96	0.93
42.00	1.00	344.18	*	0.028	0.73	0.81	0.00	0.73	0.81	1.00	0.97
44.00	1.04	344.22	*	0.028	0.75	0.84	0.00	0.75	0.84	1.04	1.01
46.00	1.07	344.25	*	0.028	0.78	0.86	0.00	0.78	0.86	1.07	1.05
48.00	1.11	344.29	*	0.028	0.80	0.89	0.00	0.80	0.89	1.11	1.09
50.00	1.15	344.33	*	0.028	0.82	0.91	0.00	0.82	0.91	1.15	1.13
52.00	1.19	344.37	*	0.028	0.84	0.93	0.00	0.84	0.93	1.19	1.16
54.00	1.22	344.40	*	0.028	0.86	0.95	0.00	0.86	0.95	1.22	1.20
56.00	1.26	344.44	*	0.028	0.88	0.98	0.00	0.88	0.98	1.26	1.24
58.00	1.30	344.48	*	0.028	0.90	1.00	0.00	0.90	1.00	1.30	1.27
60.00	1.33	344.51	*	0.028	0.92	1.02	0.00	0.92	1.02	1.33	1.31
62.00	1.37	344.55	*	0.028	0.94	1.04	0.00	0.94	1.04	1.37	1.34
64.00	1.40	344.58	*	0.028	0.96	1.06	0.00	0.96	1.06	1.40	1.38
66.00	1.44	344.62	*	0.028	0.98	1.08	0.00	0.98	1.08	1.44	1.41
68.00	1.47	344.65	*	0.028	1.00	1.10	0.00	1.00	1.10	1.47	1.45
70.00	1.50	344.68	*	0.028	1.02	1.12	0.00	1.02	1.12	1.50	1.48
72.00	1.54	344.72	*	0.028	1.04	1.14	0.00	1.04	1.14	1.54	1.51
74.00	1.57	344.75	*	0.028	1.06	1.16	0.00	1.06	1.16	1.57	1.55
76.00	1.60	344.78	*	0.028	1.08	1.18	0.00	1.08	1.18	1.60	1.58
78.00	1.64	344.82	*	0.028	1.10	1.20	0.00	1.10	1.20	1.64	1.61
80.00	1.67	344.85	*	0.028	1.12	1.22	0.00	1.12	1.22	1.67	1.64
82.00	1.70	344.88	*	0.028	1.14	1.24	0.00	1.14	1.24	1.70	1.68
84.00	1.73	344.91	*	0.028	1.16	1.26	0.00	1.16	1.26	1.73	1.71
86.00	1.76	344.94	*	0.028	1.17	1.28	0.00	1.17	1.28	1.76	1.74
88.00	1.79	344.97	*	0.028	1.19	1.30	0.00	1.19	1.30	1.79	1.77
90.00	1.82	345.00	*	0.028	1.21	1.32	0.00	1.21	1.32	1.82	1.80
92.00	1.85	345.03	*	0.028	1.23	1.34	0.00	1.23	1.34	1.85	1.83

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 94.00    1.88      345.06  * 0.028  1.25  1.36  0.00  1.25  1.36   1.88
1.86
 96.00    1.91      345.09  * 0.028  1.26  1.38  0.00  1.26  1.38   1.91
1.89
 97.00    1.93      345.11  * 0.028  1.27  1.39  0.00  1.27  1.39   1.93
1.91
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BEAU WILLERT, EIT

PROFILE BASED ON KING COUNTY BACKWATER MODELING

$Q = 97$ cfs
$Q = VA$
$97 = V[12 \times 2]$
$V \approx 4.0$ ft/sec

46' BRIDGE SPAN

12' LONG HOLLOWCORE CONCRETE PLANKS

2.00%

PAVEMENT SECTION ABOVE

H.G.L.   1.04%   H.G.L.

2' 1.93'

1.39'   1.27'

2'

1.27'

EL. = 343.18

342.70

CONCRETE FOOTING FOR END WALLS

HEADWALL, CONTINUED ALONG WETLAND CROSSING

ENGINEERED BED MATERIAL PER FISH & WILDLIFE SPECIFICATIONS

Q	= 97 cfs
DC	= 1.27 ft
DN	= 1.39 ft
TW	= 0
DO	= 1.27 ft
DE	= 1.39 ft
HWO	= 1.93 ft

Type of Structure and Entrance Design	ke	Standard Plan
Concrete Pipe		
Projecting from fill, no headwall, socket (groove) end	0.2	
Projecting from fill, no headwall Square cut end	0.5	
Mitered to conform to fill slope (beveled end section)	0.7	B-70.20
Mitered to conform to fill slope, with concrete headwall	0.7	B-75.20
Flared end sections, metal or concrete	0.5 B-70.60	Design B
Vertical headwall with wingwalls		
Socket end (groove end)	0.2 B	
Square cut end	0.5	
Rounded (radius = 1/12 D)	0.2*	
Metal and Thermoplastic Pipe or Pipe Arch		
Projecting from fill, no headwall	0.9	
Tapered end section	0.9	B-80.20, B-80.40
Mitered to conform to fill slope (beveled end section)	0.7 B-70.20	
Mitered to conform to fill slope, with concrete headwall	0.7 B-75.20	
Flared metal or thermoplastic end sections	0.5 B-70.60	Design A
Vertical headwall with wingwalls	0.5	
Any headwall with beveled inlet edges	0.2*	
Reinforced Concrete Box		
Mitered concrete headwall to conform to fill slope		
Square-edged on 3 edges	0.5	
Rounded or beveled edges on 3 sides	0.2	
Wingwalls at 30 degrees to 75 degrees to barrel		
Square edge at crown	0.4	
Rounded or beveled edge at crown	0.2*	
Wingwalls at 10 degrees to 25 degrees to barrel		
Square edge at crown	0.5	
Wingwalls parallel to barrel		
Square edge at crown	0.7	
Side or slope tapered inlet	0.2*	

*Reference Section 3-4.6 for the design of special improved inlets with very low entrance losses

**Modified for round pipe.
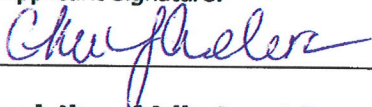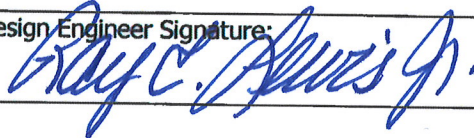
Entrance Loss Coefficient k_e

Outlet Control

Figure 3-3.4.5H

SURFACE WATER DESIGN STANDARDS
ADJUSTMENT REQUEST

Instructions to Applicant/Design Engineer:
Please complete this form and submit to the COK Public Works Department. Include all materials that may assist in a complete review and consideration of the adjustment request. Failure to provide all pertinent information may result in delayed processing or denial of request.

COK Permit Number:		Request date:	11/06/2015
Project Name:	Bridlestone Estates		
Project Address:	Approx. 4622 116th Ave NE, Kirkland, WA 98033		
Applicant Name: KLN Construction, Inc. Cher Anderson		Design Engineer Name and Firm: Roy E. Lewis, Jr., PE - Triad	
Applicant Phone: (425) 778-4111 Ext. 105		**Design Engineer Phone:** (425) 415-2052	
Applicant Signature:		Design Engineer Signature:	

Description of Adjustment Request:

The 2009 King County Surface Water Design Manual (2009 KCSWDM), Table 4.3.2.A Fish Passage Design Criteria, states that the minimum flow depth (ft) of 0.8-ft. We request an adjustment to this minimum depth of flow. The fish passage culvert provides a maximum depth of 2-ft. Based on the results of the King County Backwater Analysis that was performed for the fish passage box culvert the flow that provides a flow depth of 0.8-ft is 42 cubic feet per second through the culvert.

Justification for Adjustment Request:

The justification for this adjustment is based on the fact that flow through the culvert is not constant, and is based on the flows as a result of a given storm event.

Applicable KC Surface Water Design Manual: ☐ 1998 or ☒ 2009

Applicable Section(s) of Standards:
Table 4.3.2.A page 4-51 of the 2009 KCSWDM

COK Determination: ☐ Approved   ☐ Denied

Conditions (if applicable):

COK Staff Signature: _____   **Date:** _____